

HOT WATER SUPPLY HEAT EXCHANGER

TECHNICAL FIELD

[0001] The present invention relates to hot water supply heat exchangers used for heat pump type hot water supply apparatuses to exchange heat between water and a high-temperature refrigerant.

BACKGROUND ART

[0002] For example, in a hot water supply heat exchanger used for a heat pump type hot water supply apparatus, a scale component dissolved in water (for example, calcium carbonate) may be deposited and adhered onto the inner wall of a water passage with a rise in water temperature. This means that calcium carbonate is dissolved in running water. As illustrated by the solubility curve in FIG. 9, the degree of solubility of such calcium carbonate in running water decreases with a rise in water temperature. This causes calcium carbonate to be deposited as a scale component. The scale component deposited in the above-mentioned manner is adhered to the inner wall of a water passage. The adhesion of the scale component has been known to be pronounced especially in the following cases: a case in which the temperature of the pipe wall becomes high; a case in which the water speed is low; a case in which the water flow is disturbed; and other cases. This has restricted use of heat transfer enhancers for enhancing heat transfer from the water side and made it difficult to enhance the performance of hot water supply heat exchangers.

[0003] By the way, some hot water supply heat exchangers include a core pipe forming a water passage and a winding pipe placed around the core pipe in a spiral manner and forming a refrigerant passage and heat water flowing through the water passage by a refrigerant flowing through the refrigerant passage. Such hot water supply heat exchangers have already been suggested which can restrain a scale component from being adhered to the inner wall of a part of the core pipe located on the water outlet side and sufficiently secure a water passage even with the scale component adhered thereto to some

extent (see Patent Document 1).

Patent Document 1: Japanese Unexamined Patent Publication No. 2003-97898

DISCLOSURE OF INVENTION

Problems that the Invention is to Solve

5 [0004] However, for the hot water supply heat exchanger disclosed in the Patent Document 1, the problem that a scale component is adhered to the water outlet side can be solved but the performance of heat exchangers themselves cannot be enhanced.

[0005] The present inventors noticed that the performance of heat exchangers can be enhanced by both restraining adhesion of a scale component and enhancing heat transfer.

10 This led to the present invention.

[0006] The present invention is made in view of the above-mentioned points, and its object is to enhance the performance of a part of a heat exchanger located on the inlet side of a water passage and having water of a predetermined temperature or less.

Means of Solving the Problems

15 [0007] A first aspect of the present invention is directed toward a hot water supply heat exchanger configured to include a water pipe 1 forming a water passage **W** and a refrigerant pipe 2 forming a refrigerant passage **R** and heat water flowing through the water passage **W** by a refrigerant flowing through the refrigerant passage **R**. An inlet part **A** of the water passage **W** including water of a predetermined temperature or less is
20 provided with a heat transfer enhancer.

[0008] With the above-mentioned structure, enhanced is heat transfer from the inlet part **A** of the water passage **W** including water of a predetermined temperature or less (in other words, a heat exchanger unit including water having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply
25 enhances the performance of the whole heat exchanger. In particular, when the so-constructed hot water supply heat exchanger is used for a heat pump type hot water supply apparatus, the performance of heat transfer from the water side is typically lower

than that from the refrigerant side, and the rate of heat transfer from the water side becomes lower in a low-temperature range than that in a high-temperature range due to the influence of physical property values (for example, the rate of heat transfer that decreases with a reduction in temperature or the viscosity coefficient that increases with a reduction in temperature). In view of the above, when the inlet part A of the water passage W including water of a predetermined temperature or less is provided with the heat transfer enhancer, this very significantly enhances the performance of the heat exchanger.

[0009] A second aspect of the present invention is directed toward a hot water supply heat exchanger configured to include a water pipe 1 forming a water passage W and a refrigerant pipe 2 forming a refrigerant passage R and heat water flowing through the water passage W by a refrigerant flowing through the refrigerant passage R. A part of the water pipe 1 forming an inlet part A of the water passage W having water of a predetermined temperature or less is provided with a heat transfer enhancement pipe section.

[0010] With the above-mentioned structure, enhanced is heat transfer from the inlet part A of the water passage W including water of a predetermined temperature or less (in other words, a heat exchanger unit including water having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply enhances the performance of the whole heat exchanger. In particular, when the so-constructed hot water supply heat exchanger is used for a heat pump type hot water supply apparatus, the performance of heat transfer from the water side is typically lower than that from the refrigerant side, and the rate of heat transfer from the water side becomes lower in a low-temperature range than that in a high-temperature range due to the influence of physical property values (for example, the rate of heat transfer that decreases with a reduction in temperature or the viscosity coefficient that increases with a reduction in temperature). In view of the above, when a heat transfer enhancement pipe is used as the water pipe 1 forming an inlet part A of the water passage W having water of a

predetermined temperature or less, this very significantly enhances the performance of the heat exchanger.

[0011] A third aspect of the present invention is directed toward a hot water supply heat exchanger configured to include a plurality of heat exchanger units **H**, **H**, ... including a
5 water pipe **1** forming a part of a water passage **W** and a refrigerant pipe **2** forming a part of a refrigerant passage **R** and heat water flowing through the water passage **W** by a refrigerant flowing through the refrigerant passage **R**. The plurality of heat exchanger units **H**, **H**, ... are stacked one above another, the water pipes **1** are connected to one another to form a continuous water passage **W**, and the refrigerant pipes **2** are connected to
10 one another to form a continuous refrigerant passage **R**. An inlet part **A** of the water passage **W** including water of a predetermined temperature or less is provided with a heat transfer enhancer.

[0012] With the above-mentioned structure, enhanced is heat transfer from the inlet part **A** of the water passage **W** including water of a predetermined temperature or less (in other
15 words, a heat exchanger unit including water having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply enhances the performance of the whole heat exchanger. In particular, when the so-constructed hot water supply heat exchanger is used for a heat pump type hot water supply apparatus, the performance of heat transfer from the water side is typically lower
20 than that from the refrigerant side, and the rate of heat transfer from the water side becomes lower in a low-temperature range than that in a high-temperature range due to the influence of physical property values (for example, the rate of heat transfer that decreases with a reduction in temperature or the viscosity coefficient that increases with a reduction in temperature). In view of the above, when the inlet part **A** of the water passage **W**
25 including water of a predetermined temperature or less is provided with a heat transfer enhancer, this very significantly enhances the performance of the heat exchanger.

[0013] A fourth aspect of the present invention is directed toward a hot water supply

heat exchanger configured to include a plurality of heat exchanger units **H**, **H**, ... each including a water pipe **1** forming a part of a water passage **W** and a refrigerant pipe **2** forming a refrigerant passage **R** and heat water flowing through the water passage **W** by a refrigerant flowing through the refrigerant passage **R**. The plurality of heat exchanger units **H**, **H**, ... are stacked one above another. The water pipes **1** are connected to one another to form a continuous water passage **W**, and the refrigerant pipes **2** are connected to one another to form a continuous refrigerant passage **R**. A heat transfer enhancement pipe is used as the water pipe **1** corresponding to an inlet part **A** of the water passage **W**.

[0014] With the above-mentioned structure, enhanced is heat transfer from the inlet part **A** of the water passage **W** including water of a predetermined temperature or less (in other words, a heat exchanger unit including water having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply enhances the performance of the whole heat exchanger. In particular, when the so-constructed hot water supply heat exchanger is used for a heat pump type hot water supply apparatus, the performance of heat transfer from the water side is typically lower than that from the refrigerant side, and the rate of heat transfer from the water side becomes lower in a low-temperature range than that in a high-temperature range due to the influence of physical property values (for example, the rate of heat transfer that decreases with a reduction in temperature or the viscosity coefficient that increases with a reduction in temperature). In view of the above, when a heat transfer enhancement pipe is used for the heat exchanger unit **H** corresponding to the inlet part **A** of the water passage **W** including water of a predetermined temperature or less, this very significantly enhances the performance of the heat exchanger. In addition, since a heat transfer enhancement pipe is used for the heat exchanger unit **H** partly forming an inlet part of the water passage **W** and including water of a predetermined temperature or less, this facilitates configuring the heat exchanger unit **H** and connecting the heat exchanger unit **H** with another heat exchanger unit.

[0015] According to a fifth aspect of the present invention, in the first or third aspect of the present invention, spiral grooves 7, 7, ... formed in the inner surface of the water pipe 1 can be adopted as the heat transfer enhancer. The above-described structure can enhance the heat exchange performance of the heat exchanger while suppressing problems caused by deposition of a scale component and reduce the increase in pressure loss on the water side and the cost increase to a larger extent than other heat transfer enhancement pipes.

[0016] According to a sixth aspect of the present invention, in the second or fourth aspect of the present invention, an internally-grooved pipe provided at its inner surface with spiral grooves 7, 7, ... can be adopted as the heat transfer enhancement pipe. The above-described structure can enhance the heat exchange performance of the heat exchanger while suppressing problems caused by deposition of a scale component and reduce the increase in pressure loss on the water side and the cost increase to a larger extent than other heat transfer enhancement pipes.

[0017] According to a seventh aspect of the present invention, in the first, second, third, fourth, fifth, or sixth aspect of the present invention, the refrigerant pipe 2 can be connected to the periphery of the water pipe 1. The above-mentioned structure can enhance the rate of heat transfer from the refrigerant pipe 2 to the water pipe 1, resulting in a more significantly enhanced heat exchange performance.

EFFECTS OF THE INVENTION

[0018] A first aspect of the present invention is directed toward a hot water supply heat exchanger configured to include a water pipe 1 forming a water passage W and a refrigerant pipe 2 forming a refrigerant passage R and heat water flowing through the water passage W by a refrigerant flowing through the refrigerant passage R. An inlet part A of the water passage W including water of a predetermined temperature or less is provided with a heat transfer enhancer. With the above-mentioned structure, enhanced is heat transfer from the inlet part A of the water passage W including water of a predetermined temperature or less (in other words, a heat exchanger unit including water

having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply enhances the performance of the whole heat exchanger. In particular, when the so-constructed hot water supply heat exchanger is used for a heat pump type hot water supply apparatus, the performance of heat transfer from the water side is typically lower than that from the refrigerant side, and the rate of heat transfer from the water side becomes lower in a low-temperature range than that in a high-temperature range due to the influence of physical property values (for example, the rate of heat transfer that decreases with a reduction in temperature or the viscosity coefficient that increases with a reduction in temperature). In view of the above, when the inlet part A of the water passage W including water of a predetermined temperature or less is provided with the heat transfer enhancer, this very significantly enhances the performance of the heat exchanger.

[0019] A second aspect of the present invention is directed toward a hot water supply heat exchanger configured to include a water pipe 1 forming a water passage W and a refrigerant pipe 2 forming a refrigerant passage R and heat water flowing through the water passage W by a refrigerant flowing through the refrigerant passage R. A heat transfer enhancement pipe is used as the water pipe 1 forming an inlet part A of the water passage W having water of a predetermined temperature or less. With the above-mentioned structure, enhanced is heat transfer from the inlet part A of the water passage W including water of a predetermined temperature or less (in other words, a heat exchanger unit including water having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply enhances the performance of the whole heat exchanger. In particular, when the so-constructed hot water supply heat exchanger is used for a heat pump type hot water supply apparatus, the performance of heat transfer from the water side is typically lower than that from the refrigerant side, and the rate of heat transfer from the water side becomes lower in a low-temperature range than that in a high-temperature range due to the influence of

physical property values (for example, the rate of heat transfer that decreases with a reduction in temperature or the viscosity coefficient that increases with a reduction in temperature). In view of the above, when the heat transfer enhancement pipe is used as the water pipe 1 forming an inlet part A of the water passage W having water of a predetermined temperature or less, this very significantly enhances the performance of the heat exchanger.

[0020] A third aspect of the present invention is directed toward a hot water supply heat exchanger configured to include a plurality of heat exchanger units H, H, ... each including a water pipe 1 forming a part of a water passage W and a refrigerant pipe 2 forming a part of a refrigerant passage R and heat water flowing through the water passage W by a refrigerant flowing through the refrigerant passage R. The plurality of heat exchanger units H, H, ... are stacked one above another, the water pipes 1 are connected to one another to form a continuous water passage W, and the refrigerant pipes 2 are connected to one another to form a continuous refrigerant passage R. An inlet part A of the water passage W including water of a predetermined temperature or less is provided with a heat transfer enhancer. With the above-mentioned structure, enhanced is heat transfer from the inlet part A of the water passage W including water of a predetermined temperature or less (in other words, a heat exchanger unit including water having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply enhances the performance of the whole heat exchanger. In particular, when the so-constructed hot water supply heat exchanger is used for a heat pump type hot water supply apparatus, the performance of heat transfer from the water side is typically lower than that from the refrigerant side, and the rate of heat transfer from the water side becomes lower in a low-temperature range than that in a high-temperature range due to the influence of physical property values (for example, the rate of heat transfer that decreases with a reduction in temperature or the viscosity coefficient that increases with a reduction in temperature). In view of the above, when the inlet part A of the water

passage **W** including water of a predetermined temperature or less is provided with the heat transfer enhancer, this very significantly enhances the performance of the heat exchanger.

[0021] A fourth aspect of the present invention is directed toward a hot water supply
5 heat exchanger configured to include a plurality of heat exchanger units **H**, **H**, ... each including a water pipe **1** forming a part of a water passage **W** and a refrigerant pipe **2** forming a refrigerant passage **R** and heat water flowing through the water passage **W** by a refrigerant flowing through the refrigerant passage **R**. The plurality of heat exchanger units **H**, **H**, ... are stacked one above another. The water pipes **1** are connected to one
10 another to form a continuous water passage **W**, and the refrigerant pipes **2** are connected to one another to form a continuous refrigerant passage **R**. A heat transfer enhancement pipe is used as the water pipe **1** corresponding to an inlet part **A** of the water passage **W**. With the above-mentioned structure, enhanced is heat transfer from the inlet part **A** of the water passage **W** including water of a predetermined temperature or less (in other words, a
15 heat exchanger unit including water having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply enhances the performance of the whole heat exchanger. In particular, when the so-constructed hot water supply heat exchanger is used for a heat pump type hot water supply apparatus, the performance of heat transfer from the water side is typically lower than that from the
20 refrigerant side, and the rate of heat transfer from the water side becomes lower in a low-temperature range than that in a high-temperature range due to the influence of physical property values (for example, the rate of heat transfer that decreases with a reduction in temperature or the viscosity coefficient that increases with a reduction in temperature). In view of the above, when the heat transfer enhancement pipe is used for
25 the heat exchanger unit **H** corresponding to the inlet part **A** of the water passage **W** including water of a predetermined temperature or less, this very significantly enhances the performance of the heat exchanger. In addition, since a heat transfer enhancement pipe

for enhancing heat transfer is used for the heat exchanger unit **H** partly forming an inlet part of the water passage **W** and including water of a predetermined temperature or less, this facilitates configuring the heat exchanger unit **H** and connecting the heat exchanger unit **H** with another heat exchanger unit.

5 [0022] According to a fifth aspect of the present invention, in the first or third aspect of the present invention, spiral grooves 7, 7, ... formed in the inner surface of the water pipe 1 can be adopted as the heat transfer enhancer. The above-described structure can enhance the heat exchange performance of the heat exchanger while suppressing problems caused by deposition of a scale component and reduce the increase in pressure loss on the water
10 side and the cost increase to a larger extent than other heat transfer enhancement pipes.

[0023] According to a sixth aspect of the present invention, in the second or fourth aspect of the present invention, an internally-grooved pipe provided at its inner surface with spiral grooves 7, 7, ... can be adopted as the heat transfer enhancement pipe. The above-described structure can enhance the heat exchange performance of the heat
15 exchanger while suppressing problems caused by deposition of a scale component and reduce the increase in pressure loss on the water side and the cost increase to a larger extent than other heat transfer enhancement pipes.

[0024] According to a seventh aspect of the present invention, in the first, second, third, fourth, fifth, or sixth aspect of the present invention, the refrigerant pipe 2 can be
20 connected to the periphery of the water pipe 1. The above-mentioned structure can enhance the rate of heat transfer from the refrigerant pipe 2 to the water pipe 1, resulting in a more significantly enhanced heat exchange performance.

BRIEF DESCRIPTION OF DRAWINGS

[0025] [FIG. 1] FIG. 1 is a plan view of a hot water supply heat exchanger
25 according to an embodiment of the present invention.

[FIG. 2] FIG. 2 is a side view of a hot water supply heat exchanger according to the embodiment of the present invention.

[FIG. 3] FIG. 3 is a partially developed plan view illustrating an exemplary heat transfer enhancement pipe adopted for the hot water supply heat exchanger according to the embodiment of the present invention.

[FIG. 4] FIG. 4 is a partially developed plan view illustrating another exemplary heat transfer enhancement pipe adopted for the hot water supply heat exchanger according to the embodiment of the present invention.

[FIG. 5] FIG. 5 is a partially developed plan view illustrating still another exemplary heat transfer enhancement pipe adopted for the hot water supply heat exchanger according to the embodiment of the present invention.

[FIG. 6] FIG. 6 is a partially developed plan view illustrating yet another exemplary heat transfer enhancement pipe adopted for the hot water supply heat exchanger according to the embodiment of the present invention.

[FIG. 7] FIG. 7 is a partially developed plan view illustrating a further exemplary heat transfer enhancement pipe adopted for the hot water supply heat exchanger according to the embodiment of the present invention.

[FIG. 8] FIG. 8 is a partially developed plan view illustrating a still further exemplary heat transfer enhancement pipe adopted for the hot water supply heat exchanger according to the embodiment of the present invention.

[FIG. 9] FIG. 9 is a characteristic graph illustrating the solubility curve of calcium carbonate.

Description of Numerals

[0026] 1 water pipe
 1' heat transfer enhancement pipe
 2 refrigerant pipe
 7 spiral grooves
 A inlet part
 H(H1, H2) heat exchanger unit

R refrigerant passage

W water passage

BEST MODE FOR CARRYING OUT THE INVENTION

[0027] A preferred embodiment of the present invention will be described hereinafter
5 with reference to the accompanying drawings.

[0028] A hot water supply heat exchanger of this embodiment serves as a heat exchanger
for water used as a heater of a heat pump type hot water supply apparatus. As illustrated
in FIGS. 1 and 2, this hot water supply heat exchanger is configured such that each of two
heat exchanger units **H1** and **H2** each include a water pipe **1** forming a spiral water passage
10 **W** in the form of an ellipse when viewed in plan and a refrigerant pipe **2** helically placed
around the water pipe **1** to form a refrigerant passage **R** and are stacked one above the
other. Furthermore, the water pipes **1** are connected to each other to form a continuous
water passage **W**, and the refrigerant pipes **2** are connected to each other to form a
continuous refrigerant passage **R**.

15 [0029] The water pipe **1** for the upper heat exchanger **H2** is connected near the middle of
the spiral through a connector **3** to the water pipe **1** for the lower heat exchanger unit **H1**.
The refrigerant pipe **2** placed around the water pipe **1** for the upper heat exchanger unit **H2**
is connected near the middle of the spiral through connectors **4** to the refrigerant pipe **2**
placed around the water pipe **1** for the lower heat exchanger unit **H1**. An outermost part
20 of the spiral forming the water pipe **1** for the lower heat exchanger unit **H1** is provided
with an inlet **5** of the water passage **W**. An outermost part of the spiral forming the water
pipe **1** for the upper heat exchanger unit **H2** is provided with the last outlet **6** of the water
passage.

[0030] A pipe for enhancing heat transfer (hereinafter, referred to as "heat transfer
25 enhancement pipe") provided with a heat transfer enhancer is used as the water pipe **1** for
the lower heat exchanger unit **H1** forming an inlet part of the water passage **W** and having
water of a predetermined temperature or less.

[0031] With the above-mentioned structure, enhanced is heat transfer from the water pipe 1 for the lower heat exchanger unit **H1** forming an inlet part of the water passage **W** and having water of a predetermined temperature or less (in other words, a heat exchanger unit including water having a temperature at which calcium carbonate, i.e., a scale component, is hardly deposited) to the water side. This sharply enhances the performance of the whole heat exchanger. In addition, since the heat transfer enhancement pipe is used for the lower heat exchanger unit **H1** forming an inlet part of the water passage **W** and having water of a predetermined temperature or less, this facilitates configuring the heat exchanger unit **H1** and connecting the heat exchanger unit **H1** with another heat exchanger unit (i.e., the upper heat exchanger unit **H2**).

[0032] Various pipes that have conventionally been well known can be used as heat transfer enhancement pipes. Such pipes are typified by the following pipes.

[0033] As illustrated in FIG. 3, an internally grooved pipe formed at its inner surface with spiral grooves 7, 7, ... (in other words, heat transfer enhancers) can be adopted as a heat transfer enhancement pipe 1'. In this case, the depth h of each groove is equal to 0.05 through 0.5 mm (preferably 0.2 mm), the pitch p between adjacent ones of the grooves is equal to 5 through 12 mm (preferably 7.2 mm), and the lead angle α is equal to 5 through 30 degrees (preferably 15 degrees). The above-mentioned structure can enhance the heat exchange performance of the heat exchanger while suppressing problems caused by deposition of a scale component and reduce the increase in pressure loss on the water side and the cost increase to a larger extent than other heat transfer enhancement pipes. As illustrated in FIG. 4, an internally grooved pipe formed at its inner surface with asymmetrical grooves 8, 8, ... (in other words, heat transfer enhancers) can be adopted as a heat transfer enhancement pipe 1'. As illustrated in FIG. 5, a pipe formed at its inner surface with a cross fin 9 (in other words, a heat transfer enhancer) can be adopted as a heat transfer enhancement pipe 1'. As illustrated in FIG. 6, a pipe formed at its inner surface with many fins 10, 10, ... (in other words, heat transfer enhancers) extending in the

centripetal direction of the pipe can be adopted as a heat transfer enhancement pipe 1'. As illustrated in FIG. 7, a twisted-tape-inserted pipe into which a twisted tape 11 (in other words, a heat transfer enhancer) is inserted can be adopted as a heat transfer enhancement pipe 1'. A corrugated pipe illustrated in FIG. 8 can be adopted as a heat transfer enhancement pipe 1'. Other thin pipes can be adopted as heat transfer enhancement pipes 1'.

[0034] When three or more heat exchanger units **H**, **H**, ... are stacked one above another and the number of the heat exchanger units **H**, **H**, ... is **N**, respective core pipes of the first through (**N**-1)-th heat exchanger units from the inlet side can be heat transfer enhancement pipes.

[0035] In the above embodiment, a water pipe 1 for a heat exchanger unit **H** is spirally formed, and a refrigerant pipe 2 is helically placed around the water pipe 1. However, the water pipe 1 for the heat exchanger unit **H** can take any other form. Furthermore, the refrigerant pipe 2 need only be connected to the periphery of the water pipe 1, and the shape of the refrigerant pipe 2 connected to the water pipe 1 can be freely chosen.

[0036] The above-mentioned provision of a heat transfer enhancer at a water passage also includes a case in which a water flow disturber for disturbing the water flow (for example, a vibration-applying unit or any other unit) is provided on the inlet side of the so-constructed hot water supply heat exchanger.

[0037] Furthermore, the present invention is not limited to the above embodiment, and it is apparent that various modifications may be made.

INDUSTRIAL APPLICABILITY

[0038] As described above, the present invention is useful as hot water supply heat exchangers for heating water through a water passage by a refrigerant through a refrigerant passage.